UCRL-JC-120735 Abs Rev 1

Kinetic Simulations of Intense Ultra-Short-Pulse Laser Light on Thin Targets*

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We investigate the interaction of high-intensity, short-pulse lasers with thin, solid-density targets using kinetic particle-in-cell simulations. The simulations are one-dimensional in space with three velocity components, and electron-ion Coulomb collisions are included. The plasma is initialized as a cold, fully-ionized plasma slab with sharp density jumps from vacuum to solid material. Our nominal case is a 100 nm thick aluminum target, illuminated by 400 nm wavelength light with a 100 fs full-width-half-maximum Gaussian time history. When the peak laser intensity is $I=10^{18}$ W/cm^2, the fractional absorption is approximately 3% with mean electron energies of about 20 keV. At 10^{19} W/cm^2, a sizable population of high-energy (>100 keV) electrons appears, and the absorption increases to 7%. The absorption increases to 12% for $I=10^{20}$ W/cm^2, and at $I=10^{21}$ W/cm^2 it increases to 20%. At the higher intensities, some electrons reach several MeV. The absorption, once the plasma reaches a few keV, is collisionless, and the mechanism appears to be that proposed by Kruer and Estabrook. This mechanism relies on the pulsed nature of the electromagnetic ponderomotive force. Following the absorption of energy by the electrons, the ions are accelerated by the ambipolar field. For the 10^{20} W/cm^2 intensity, some ions are accelerated to more than 100 MeV (~0.1*c*). These ions may be useful for bombarding a secondary target. We will show further results, varying target thickness, pulse length, pulse shape, and laser wavelength.

***** This work was performed under the auspices of the U. S. Department of Energy by Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.